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An Updated Arbitrary-Lagrangian-Eulerian Description in Continuum Mechanics and Its Application to Nonlinear Fluid-Structure Interaction Dynamics

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An updated Arbitrary-Lagrangian-Eulerian (UALE) coordinate system is proposed to solve problems in continuum mechanics. It is compared to and distinguished from an ALE system. The governing equations in differential and integral forms in an UALE system are derived. A key feature of the UALE system is that the current position coordinates defined in a Cartesian Eulerian Spatial System (CESS) are chosen as the reference coordinates to investigate the motion of the continuum. When the reference point moves to a new position, the reference coordinates are updated to the new position coordinates in CESS. This UALE system and the updated Lagrangian (UL) system have the same base vectors as the CESS at each point in space, which provides a convenient way to overcome fundamental difficulties occurring in a nonlinear fluid-structure analysis. In the fluid's UALE system and the solid's UL system in solids, variational principles and a mixed finite element – finite volume approach for nonlinear fluid-structure interaction dynamics are developed and formulated.

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